

This question paper contains 4 printed pages.]

Your Roll·No. ....

**1240**

**B.Sc. (H) CHEMISTRY / II Sem. A**

**Paper – CHHT-203**

**Physical Chemistry**

**(Admission of 2010 and onwards)**

**Time : 3 Hours**

**Maximum Marks : 75**

*(Write your Roll No. on the top immediately on receipt of this question paper.)*

Attempt **six** questions in all, selecting at least **two** questions from each section. Question No. 1 is compulsory.

Use of scientific calculators and Log Tables is allowed.

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}; N_A = 6.022 \times 10^{23} \text{ mol}^{-1}; \\ k = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

1. Explain the following giving reasons (any 5) :
  - (a) An ideal gas cannot be liquefied.
  - (b) Viscosity of glycerol is much more than that of ether.
  - (c) Both NaCl and KCl have FCC unit cells but KCl behaves like a simple cubic unit cell towards X-ray Diffraction.
  - (d) CO and N<sub>2</sub> have the same velocity distribution at a particular temperature.

- (e) The physical significance of 'a' and 'b' in the van der Waals equation of state.
- (f) Phenolphthalein is not a suitable indicator for a strong acid-weak base titration.
- (g) Irrespective of their nature, drops of all liquids, falling freely in air are spherical in shape. (5 × 3)

### SECTION - A

2. (a) Derive an expression for Boyle's temperature for a van der Waals gas in terms of the constants a, b and R, where R is the gas constant and a and b are the van der Waals constants.
- (b) Barometric formula for gases is  $p = p_0 \exp(-Mgh/RT)$ .  
Show that the height at which the atmospheric pressure is reduced to half its value, is given by the expression  
$$h = 0.6932 RT/Mg$$
- (c) State the Maxwell's law for the distribution of speeds of molecules of a gas. Show with the help of a diagram, how a change in temperature of the gas influences this distribution. (5, 4, 3)
3. (a) What is the Law of corresponding states? Explain its significance.
- (b) Calculate the temperature at which the average speed of hydrogen gas equals that of oxygen gas at 320 K.
- (c) Derive the formulas for the critical constants  $T_c$ ,  $P_c$  and  $V_c$  from the van der Waals equation of state. (3, 4, 5)

4. (a) What is the value of the compressibility factor ( $Z$ ) of a real gas as pressure approaches zero ?
- (b) Out of Hydrogen, Oxygen and Methane which will have the highest kinetic energy per mole at the same temperature and pressure, and why ?
- (c) Derive the equation for collision frequency  $Z_{11}$  in the case of a gas.
- (d) The root mean square velocity of Hydrogen gas at STP is  $1.83 \times 10^3$  m/s and its mean free path is  $1.78 \times 10^{-7}$  m. Calculate its collision number. (2, 2, 4, 4)
5. (a) In the determination of surface tension by drop number method, equal volumes of liquid A and water give 60 and 20 drops respectively. Calculate the surface tension of A if surface tension of water is  $72.75 \times 10^{-3}$  Nm<sup>-1</sup>, density of liquid A =  $0.896$  g cm<sup>-3</sup> and density of water =  $0.964$  g cm<sup>-3</sup>.
- (b) How do the viscosities of liquids and gases vary with temperature ?
- (c) Explain how the addition of soap to water enhances its cleaning properties. (5, 4, 3)

### SECTION - B

6. (a) What is the pH of pure water at  $100^\circ\text{C}$  ?  
( $K_w$  at  $100^\circ\text{C}$  is  $56 \times 10^{-14}$ )
- (b) Derive the Henderson equation for determining the pH of a buffer solution.

- (c) Calculate the pH value of a solution obtained by mixing 500 mL of 0.1 M  $\text{CH}_3\text{COOH}$  and 500 mL of 0.1 M  $\text{CH}_3\text{COONa}$ .  $K_a$  of acetic acid is  $1.8 \times 10^{-5}$ .  
(4, 3, 5)
7. (a) The degree of hydrolysis of a deci molar solution of KCN is one percent. What is the value of the hydrolysis constant of this salt?  
(b) Derive relationships for the hydrolysis constant, degree of hydrolysis and the pH of a salt of a strong base and a weak acid.  
(c) What is the solubility of  $\text{Ca}(\text{OH})_2$  in a solution buffered to pH 12. The solubility product of  $\text{Ca}(\text{OH})_2$  is  $5.5 \times 10^{-6}$ ? (4, 4, 4)
8. (a) Derive Bragg's Law. What is the Physical significance of 'n' in Bragg's equation?  
(b) The tetragonal structure does not have face centered and end centered Bravais lattice. Explain with the help of diagrams.  
(c) Differentiate between Point group and Space group. (5, 4, 3)
9. (a) What are Miller indices? Calculate Miller indices for following:  
(i) 0a, 2b, 1c (ii) 2.5a, 2.5b, 3c  
(b) Calculate  $d_{231}$ , the distance between two layers in a cubic crystal of unit cell edge 3.0 Angstrom units. The 'hkl' Miller indices of these layers are 231.  
(c) Explain the powder pattern method for determining crystal structure. (4, 4, 4)